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TELEOST FISH REMAINS (OSTEOGLOSSIDAE, BLOCHIIDAE, SCOMBRIDAE, TRIODONTIDAE, DIODONTIDAE) FROM THE LOWER EOCENE NANJEMOY FORMATION OF MARYLAND

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Abstract.—Six taxa of teleost fishes have been recognized from the Nanjemoy Formation of Maryland. So far, all collected remains have been fragmentary. The recognized taxa are: *Brychaetus muelleri, Cylindracanthus rectus, Sarda delheidi, Cybium* sp., *Triodon antiquus,* and *Kyrtogymnodon* sp. No previous records of teleosts from this formation are known.

Except for a preliminary report on the remains described herein (Horman and Weems 1976), no specific reports of teleosts from the Nanjemoy Formation of Maryland or Virginia are known, though Fallah (1964) referred to a *Cylindracanthus* specimen collected from the Pamunkey Group, which could have come from either the Aquia or Nanjemoy Formation. Collecting during the last 15 years has yielded sparse but reasonably diagnostic fragmentary remains, which represent what could have been an abundant and diverse teleost fauna. Two or more bones from the same individual, fish or tetrapod, have never been reported from the Nanjemoy. This lack of even semi-articulated remains is in marked contrast to conditions in the underlying Paleocene Aquia Formation and the overlying Miocene Calvert Formation. The sparsity of identifiable fish bones in the Nanjemoy may be the result of a very low rate of clastic influx and a hard substrate, so that skeletons that fell to the sea bottom became totally disarticulated and broken up. Bryozoan colonies on some bones suggest that the remains lay on the sea bed for some time before burial.

All teleost remains described herein were collected from the bluffs upriver and downriver from Popes Creek, Maryland (Fig. 1). In these bluffs, Clark and Martin (1901) recognized two members within the Nanjemoy Formation, a lower Potapaco Member and an upper Woodstock Member (Fig. 2). Though separated in these bluffs by a prominent layer of calcareous nodules, the members are largely defined on faunal grounds, and to our knowledge, an ability to map these members outside of the vicinity of the Popes Creek bluffs on physical stratigraphic grounds has not been demonstrated. Because the base of the Nanjemoy (the contact with the underlying Marlboro Clay) and the top of the Nanjemoy (the unconformable contact with the overlying basal phosphate bed of the Calvert Formation) are mappable stratigraphic contacts, the Nanjemoy as a whole is a mappable stratigraphic unit (Glaser 1971; Teifke 1973). Our work was done in the type area where the marker horizon between the two Nanjemoy members is readily seen; hence their names are retained for this report. Elsewhere, the members might be only biostratigraphic subdivisions of the Nanjemoy.

Only the uppermost 15 feet of the Potapaco Member is exposed above Popes Creek, so we have no basis for disputing Clark and Martin's (1901) estimate that

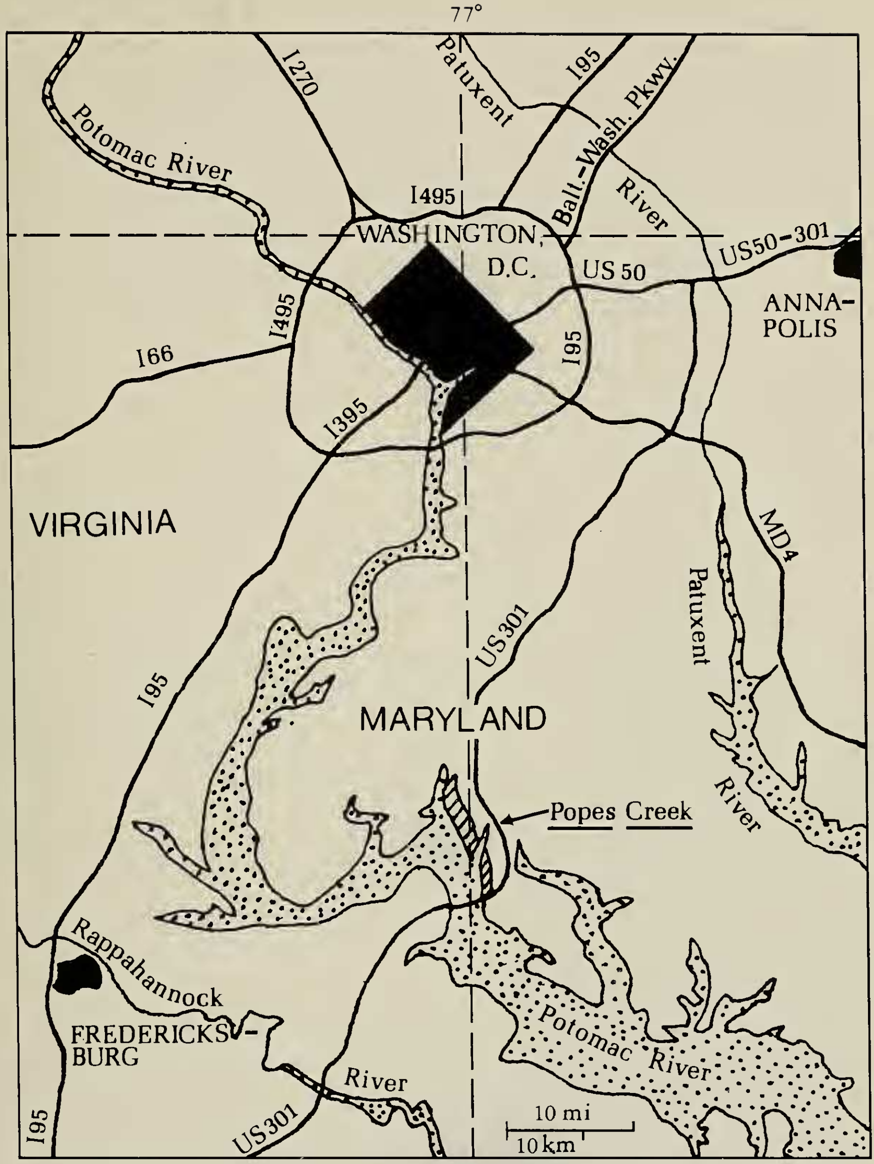
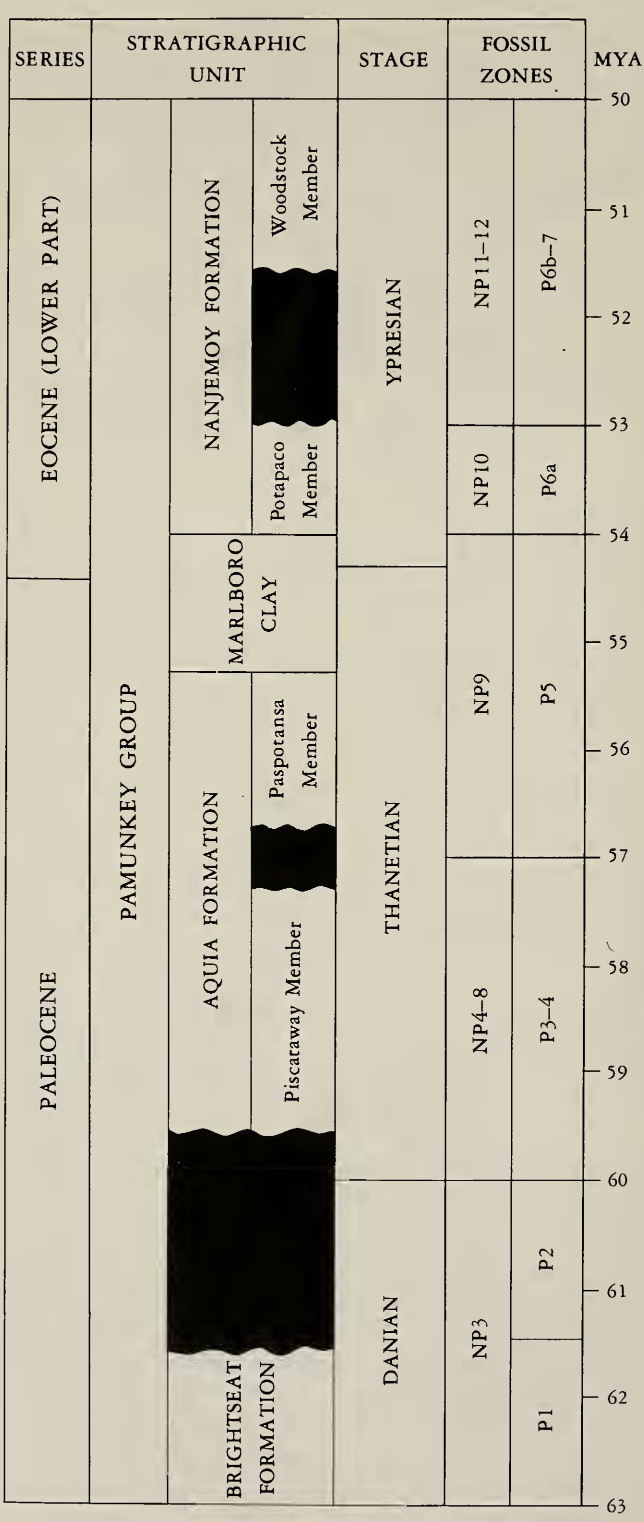


Fig. 1. Location of the bluffs along the Potomac River near Popes Creek, Maryland (ruled area).

this member is about 70 feet thick. Our own estimates on the thickness of the Woodstock Member, however, suggest that this member as Clark and Martin defined it at Popes Creek is 80 feet thick in the outcropping area instead of the 50 to 60 feet they reported (Clark and Martin 1901:66). Curiously, their diagrammatic column of the Pamunkey Group indicates a thickness for the Woodstock of about 80 feet, suggesting that the published thickness may have been a typographical error. According to our estimates, Popes Creek marks the spot at which 50 feet of the Woodstock has passed below sea level. North of Popes Creek, a thin and apparently laterally impersistent layer of coarse sand and phosphate


SERIES
STRATIGRAPHIC UNIT
STAGE
FOSSIL ZONES
MYA
EOCENE (LOWER PART)
PALEOCENE
PAMUNKEY GROUP
NANJEMOY FORMATION
Woodstock Member
Potapaco Member
MARLBORO CLAY
AQUIA FORMATION
Paspotansa Member
Piscataway Member
BRIGHTSEAT FORMATION
YPRESIAN
THANETIAN
DANIAN
NP11–12
NP10
NP9
NP4–8
NP3
P6b–7
P6a
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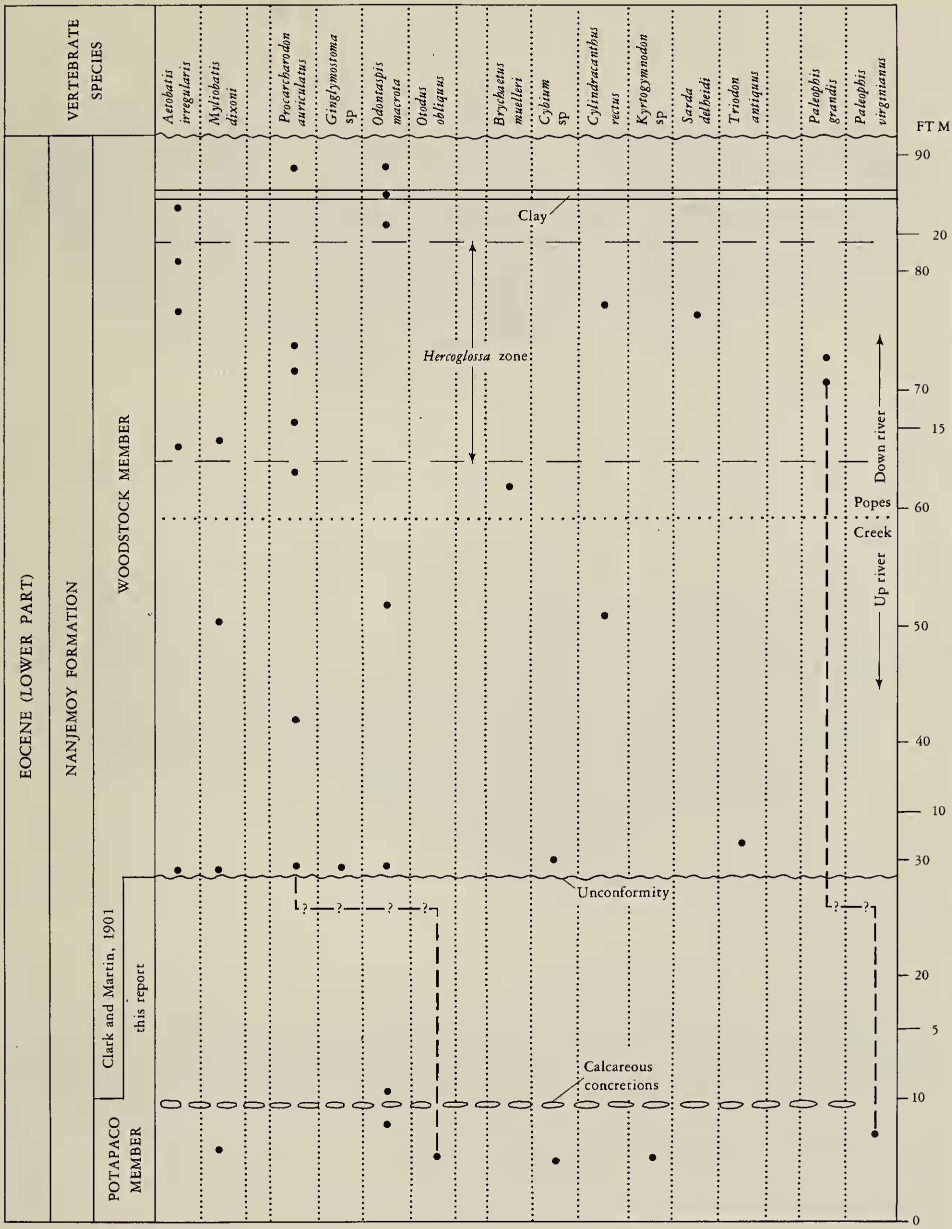

Fig. 3. Known range of some species of vertebrates collected from the Nanjemoy Formation at Popes Creek, Maryland. Except for *Myliobatis*, *Aetobatis*, *Ginglymostoma*, and *Odontaspis*, which are relatively abundant, dots represent single collected specimens.

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Fig. 2. Stratigraphic column of the Pamunkey Group (from Clark and Martin 1901, and Gibson *et al.* 1980), showing the age ranges of the various formations and groups. MYA = millions of years ago.

pebbles offers the only well defined datum from which thickness estimates can be based. This bed is considered to be 20 feet above the base of the Woodstock Member as defined by Clark and Martin (1901). South of Popes Creek, the only persistent marker bed is a thin, 1–4 inch thick layer of carbonaceous plastic light-gray clay 76 feet above the base of the Woodstock and 4 feet from its top as exposed. Specimens of the large nautiloid, *Hercoglossa tuomeyi* Clark and Martin, are known only from an interval 55–70 feet above the base of the Woodstock. Figure 3 portrays graphically the estimated position of these horizons, as well as the position of the teleost remains described below and some other vertebrate remains.

Besides teleosts, rare fragmentary remains of crocodiles, turtles, and the "sea snake" *Paleophis* are found in the Nanjemoy. Teeth of sharks and skates are more common than other vertebrate remains. Teeth of the shark *Otodus obliquus* Agassiz occur throughout the Aquia Formation and Potapaco Member, and those of the shark *Procarcharodon auriculatus* (de Blainville) are found throughout the Woodstock Member, but teeth of the two species do not occur together. The serrated tooth margin of *P. auriculatus* is the only difference between the two species; hence, these forms may represent a single lineage. If so, the two forms are good index fossils for distinguishing each respective member. In addition, the ray *Aetobatis irregularis* Leriche has not been reported in the Potapaco Member even though it is common throughout the Woodstock Member. Vertebrae of *Paleophis* are rare; only *P. virginianus* Lynn is present in the Potapaco, whereas the Woodstock vertebrae are referrable to *P. grandis* (Marsh). Thus, there seems to be a detectable vertebrate biostratigraphic break between the Potapaco and the Woodstock comparable to that found in the invertebrate assemblages (Clark and Martin 1901), though the phosphate pebble bed 20 feet above the basal concretion bed seems a more reasonable location for a time break. This break probably affects the teleost distributions as well, but the teleost sample is far too sparse for any prediction to be made on which species might be confined to one member or the other.

On the basis of the first appearance of *Procarcharodon auriculatus,* Leriche (1943) wanted to correlate the Woodstock with the Lutetian (Middle Eocene) of Europe, but since then *P. auriculatus* has been reported from the Ypresian (Lower Eocene) of Britain as far down as approximately the base of nannoplankton zone NP13 (Hooker *et al.* 1980). On the basis of microfossil correlations, the Woodstock recently has been placed in the slightly older lower to middle Ypresian fossil zones NP11 and 12 (Gibson *et al.* 1980). Since control on the boundaries of Paleogene nannoplankton zones in Britain is not good (Hooker *et al.* 1980), this slight difference in the time of first appearance for *P. auriculatus* on either side of the Atlantic may be more apparent than real. If it is real, then *P. auriculatus* appeared slightly earlier in the western Atlantic than in the eastern Atlantic. In either case, an Ypresian age for the Woodstock is compatable with all available data. The underlying Marlboro Clay of late Paleocene and early Eocene age (Gibson *et al.* 1980) overlies the Aquia Formation, which has been well documented as Late Paleocene in age (Loeblich and Tappan 1957; Bybell and Govoni 1977; Gibson *et al.* 1980). Thus, these data indicate that the Potapaco Member also must be Early Eocene (Ypresian) in age.

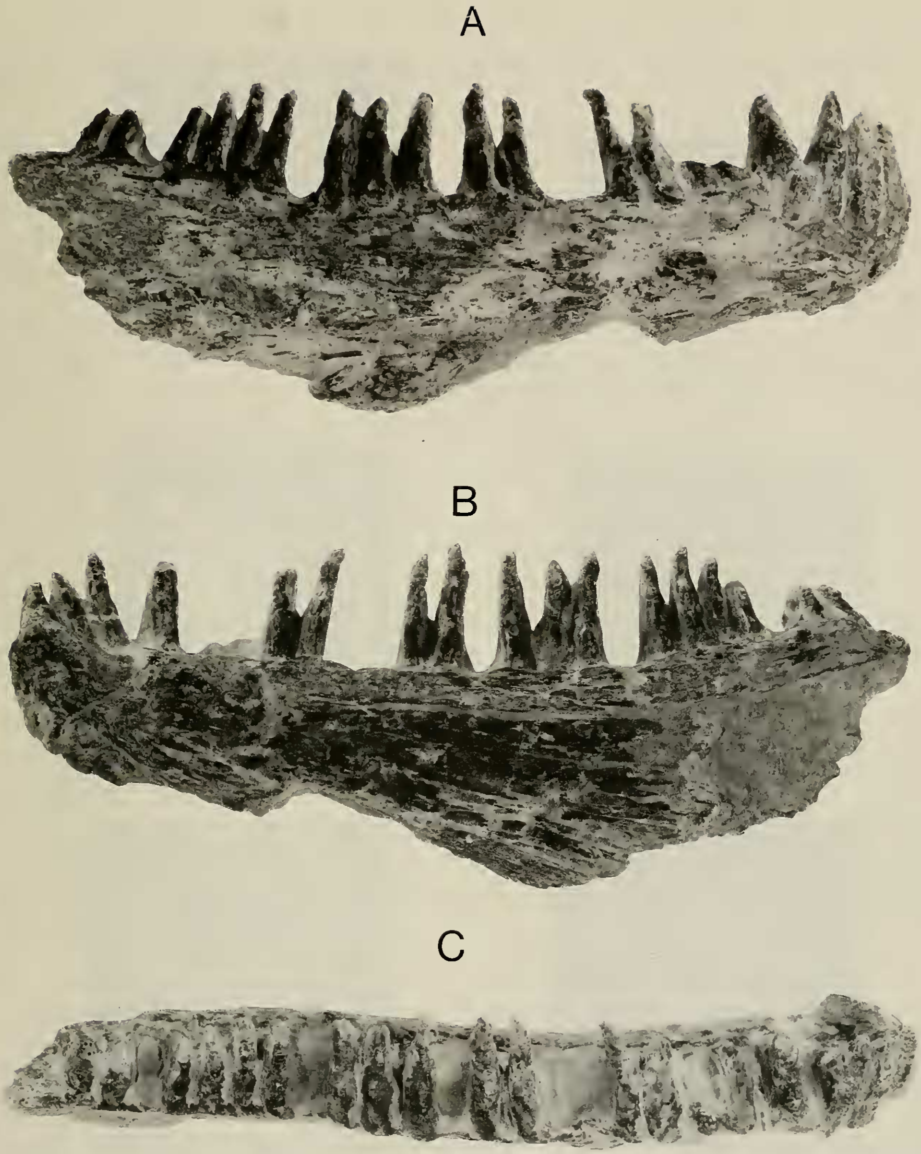

Fig. 4. Right dentary of *Brychaetus muelleri* in external (A), internal (B), and dorsal (C) aspects. Length 17 cm.

Order Osteoglossiformes
Family Osteoglossidae
Brychaetus muelleri Woodward

Material.—Right dentary containing 17 teeth and 8 empty alveoli (USNM 265383), Fig. 4.

Locality.—Bluff 100 yards south of Popes Creek, Maryland, within uppermost

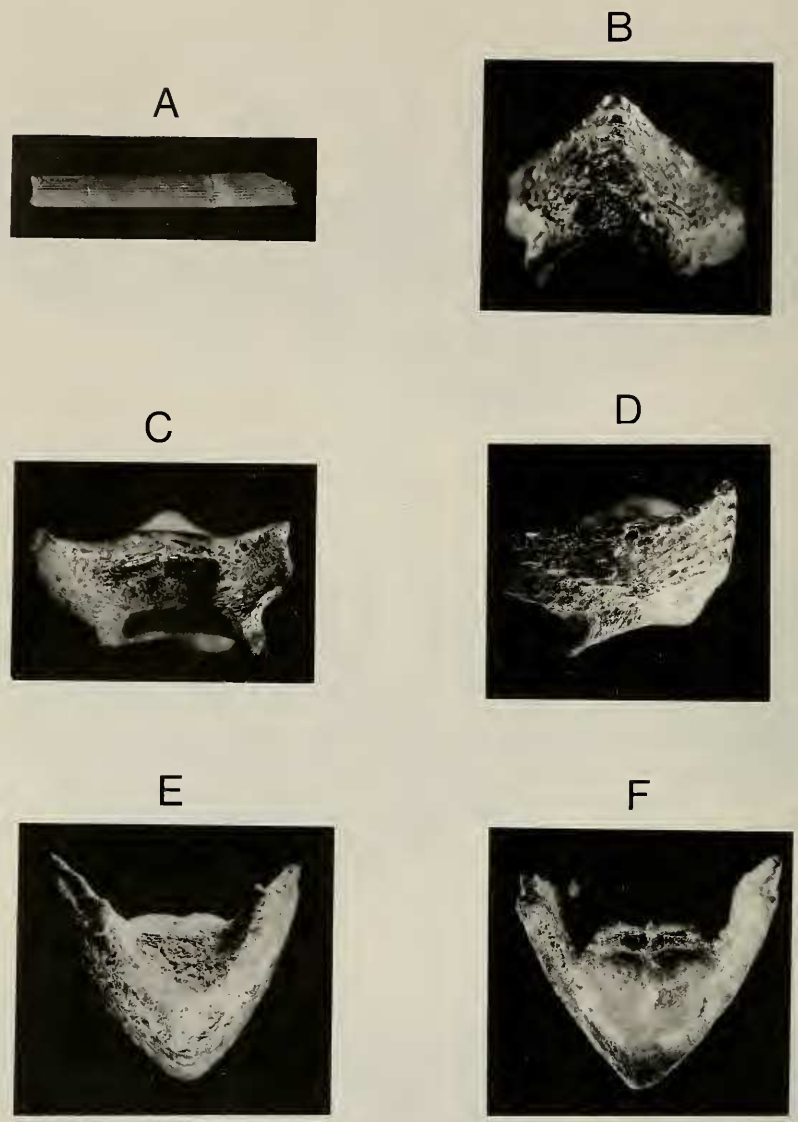

Fig. 5. A. Rostral fragment of *Cylindracanthus rectus*. Length 5.25. cm. B–F. Dentary of *Triodon antiquus* in anterior (B), posterior (C), right-lateral (D), ventral (aboral) (E), and dorsal (oral) (F) aspects. Length along midline, 6 mm; width at rear of jaw rami, 10 mm.

10 feet of the Woodstock Member, Nanjemoy Formation ("Zone 17" of Clark and Martin 1901), coll. John Glaser, 1972.

Discussion.—This large dentary with its hollow, laterally wide, anteroposteriorly compressed, and lingually recurved teeth is highly distinctive and readily referrable to *B. muelleri* (compare with Casier 1966). This teleost is by far the largest known from the Nanjemoy and probably was one of the most formidable marine carnivores of its time. *Phareodus*, a related osteoglossid from the Eocene Green River shales, is only about one-sixth as large, has a proportionally deeper jaw, and teeth that are not nearly so lingually recurved. *Brychaetus* has not been previously reported from the Lower Eocene of North America (Horman and Weems 1976).

Order Perciformes
Family Blochiidae
Cylindracanthus rectus (Agassiz)

Material.—Two rostral fragments, one of which (USNM 265384) is shown in Fig. 5(A).

Locality.—(1) Bluff ⅛ mile north of Popes Creek, Maryland, 4 feet above beach, Woodstock Member, Nanjemoy Formation, coll. Robert E. Weems, 1973; (2) USNM 265384, bluff ½ mile south of Popes Creek, Maryland, 2 feet above beach, Woodstock Member, Nanjemoy Formation, coll. Robert E. Weems, 1975.

Discussion.—Fragmentary rostra referred to this genus are fairly common in lower Tertiary sediments of North America and Europe (for example, Fallah 1964). Several species have been named, but most are based on such fragmentary material that their validity is questionable. The specimens described here are fully comparable with *C. rectus,* the first named species of the genus, and are thus placed in that taxon. Until a great deal more well-preserved material becomes available, it is impossible to tell whether this is a discrete taxon or only a catch-all category for rostral fragments of any of several closely related fishes.

Family Scombridae
Sarda delheidi (Leriche)

Material.—Right dentary (USNM 265383) with 6 teeth and at least 10 empty alveoli (Fig. 6A–C).

Locality.—Bluff 1 mile south of Popes Creek, Maryland, 1 foot above beach and 15 feet below gray carbonaceous clay bed, Woodstock Member, Nanjemoy Formation ("Zone 17" of Clark and Martin 1901), coll. Robert E. Weems, December 1973.

Cybium sp.

Material.—Three isolated teeth (Fig. 6D–F).

Localities.—1) USNM 265389, bluff 2 miles north of Popes Creek, Maryland, coll. Robert E. Weems, 1973. 2) USNM 265385, USNM 265386, bluff 1 mile north of Popes Creek, Maryland, 1 foot above beach in phosphate lag deposit, Woodstock Member, Nanjemoy Formation ("Zone 16" of Clark and Martin 1901), coll. Stephen R. Horman and Robert E. Weems, July 1968.

Discussion.—Isolated teeth of this sort have been traditionally assigned to *Cybium,* (compare with Casier 1966, Leriche 1905), and occasionally even species level identifications have been attempted. The teeth illustrated here are not certainly identifiable to species but are fully comparable with teeth generally assigned to this genus.

Order Tetraodontiformes
Family Triodontidae
Triodon antiquus Leriche

Material.—Fused dentary beak (USNM 265387) with dental battery (Fig. 5B–F).

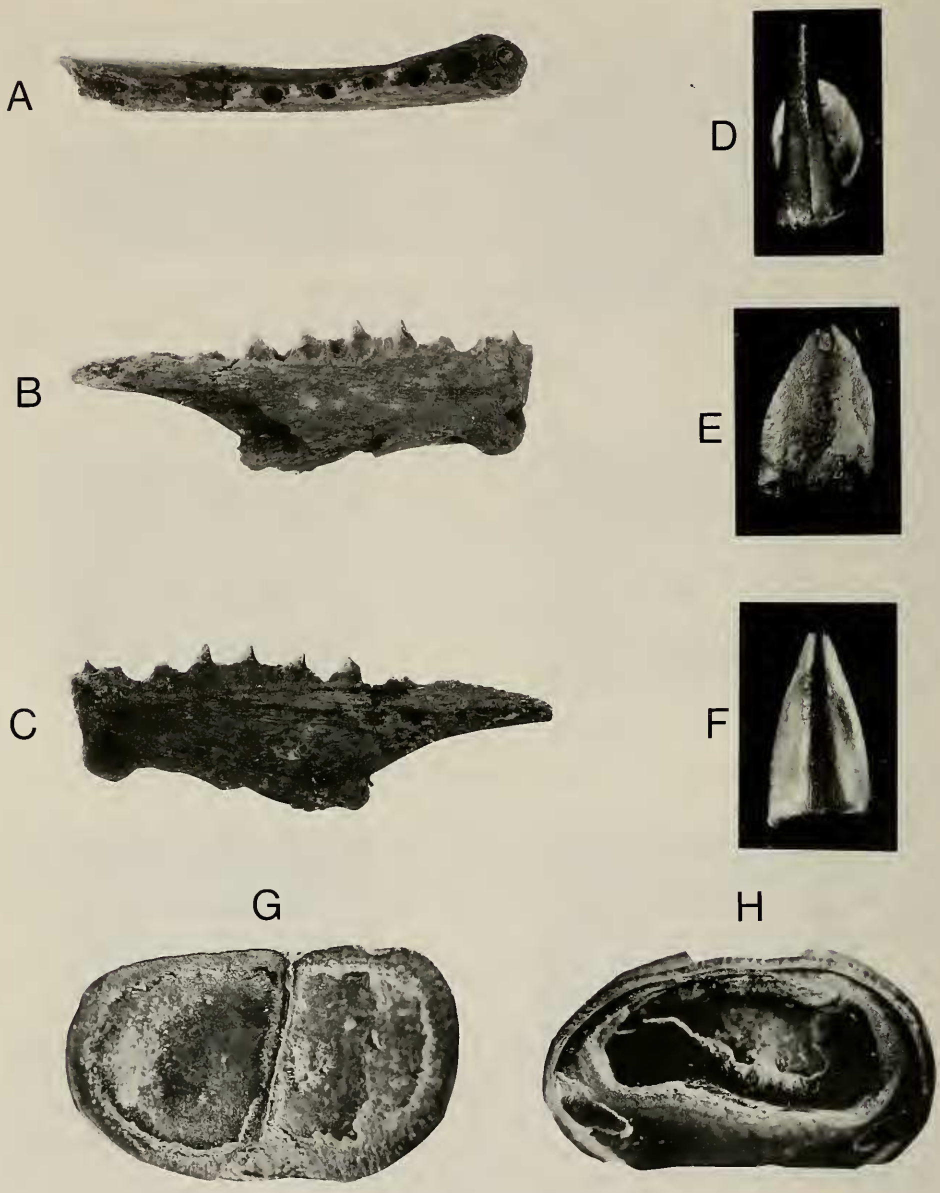

Fig. 6. A–C. Right dentary of *Sarda delheidi* in dorsal (oral) (A), external (B), and internal (C), aspects. Length 9.4 cm. D–F. Teeth referrable to *Cybium* sp. Height about 8 mm. G–H. Dental plate of *Kyrtogymnodon* sp. in internal (G) and external (H) aspects. Length 9 mm, width 15 mm.

Locality.—Bluff 1 mile north of Popes Creek, Maryland, 3 feet above beach and 2 feet above phosphate lag deposit, Woodstock Member, Nanjemoy Formation ("Zone 16" of Clark and Martin 1901), coll. Robert E. Weems and Stephen R. Horman, July 1968.

Discussion.—This fused dentary beak obviously belongs among the tetraodontiform fishes. The Molidae and Diodontidae, however, lack the scalelike teeth covering the beak margin, and the diodontidae have the tooth plates stacked imbricately, not arranged anteroposteriorly as in the Triodontidae. The only living species of this family is *Triodon bursarius* (Tyler, 1962). Fossil species of this genus are *Triodon antiquus* Leriche (1905) and *T. cabindensis* Leriche (1920). Our specimen of *Triodon* has a beak nearly as long as wide, differing markedly from the extremely laterally elongate beak of *T. cabindensis*. In general proportions it is like *T. antiquus*, being about the same size and shape. Most specimens of *T. antiquus* have beaks notably wider than long, however, whereas in this specimen the proportions are nearly equal, thus giving an exceptionally sharp and angular appearance to this beak when seen from dorsal aspect. This appears to have resulted only from proportional changes related to growth. Most figured specimens of *T. antiquus* (Leriche 1905; Casier 1946, 1960) are smaller than this specimen. When specimens are compared by absolute size, instead of relative size, the beak curvatures are quite comparable, suggesting that the differences in apparent curvature may be due to the greater individual age of our specimen than that of most of the figured specimens from Europe, whose jaw rami had not grown to be so elongate. Only two of the European specimens reach a size comparable to our specimen. In most of the figured specimens of *T. antiquus*, only juveniles have a single pair of teeth on the inferior oral surface. By the time specimens reach sizes approaching that of our specimen, one or more pairs of lateral teeth erupt as well. Thus our specimen is unusual in this respect, but in view of the highly variable nature of the dentition in figured specimens of *T. antiquus*, it is not truly distinctive when based on only a single specimen. Therefore, unless enough material becomes available to allow a statistical comparison between the European and American populations, this specimen is best referred to the highly variable *Triodon antiquus*.

This is the first record of this family from either North America or the Western Hemisphere. Today, the family is restricted to the Indian Ocean and in the past is known to have ranged into Europe and West Africa only during the Eocene. Apparently, at that time the family also managed to cross the North Atlantic into North America. If McKenna (1972) is correct in postulating a landbridge between Europe and North America through Early Eocene time, this would have afforded a warm shallow dispersal route for this family, whose distribution today suggests that it may be restricted to warm waters.

Family Diodontidae

Kyrtogymnodon sp.

Material.—Oral tooth plate, USNM 265388, (Fig. 6G–H, containing a pair of tooth batteries each containing stacks of three teeth.

Locality.—2 miles north of Popes Creek, Maryland, along a low bluff at the mouth of Nanjemoy Creek in the uppermost 10 feet of the Potapaco Member of the Nanjemoy Formation (''Zone 15'' of Clark and Martin 1901), coll. Robert E. Weems, 1973.

Discussion.—Tavani (1955) reviewed the known diodontids and arranged them within four genera. Although his suggestions concerning the definitions of genera are accepted here, it is by no means certain that species characters can be recognized from a single pair of fused plates. Moreover, it may well be that the total number of presently described species exceeds the true numbers of species represented, since individual variants may have been separately described. Therefore, the pair of fused dental plates illustrated here are merely designated *Kyrtogymnodon* sp. until better remains permit a specific diagnosis. This plate is assigned to *Kyrtogymnodon* because wear is restricted almost wholly to the central region of the most-erupted tooth. This suggests that the entire tooth battery was stacked nearly vertically so that only one tooth was worn at a time. In *Progymnodon, Oligodiodon,* and *Diodon* the batteries are stacked obliquely so that the edges of at least several teeth are functioning at the same time. If this assignment to *Kyrtogymnodon* is correct, this is by far the oldest known occurrence of this genus. Previously it has only been described from the Pliocene (Tavani 1955).

Summary

The known teleost remains from the Nanjemoy Formation can be stratigraphically arranged as follows:

Woodstock Member—	*Cylindracanthus rectus* (Agassiz)
	Triodon antiquus Leriche
	Brychaetus muelleri Woodward
	Sarda delheidi (Leriche)
	Cybium sp.
Potapaco Member—	*Kyrtogymnodon* sp.
	Cybium sp.

These species probably represent only a small fraction of the total number of teleost species originally present; conditions during deposition seem to have destroyed all remains except those from species that had exceptionally durable skeletal elements. All remains are fragmentary, and no associated skeletal materials are known.

Literature Cited

Bybell, L. M., and D. C. Govoni. 1977. Preliminary calcareous nannofossil zonation of the Brightseat and Aquia Formations (Paleocene) of Maryland and Virginia—stratigraphic implications.—American Association of Petroleum Geologists, National Meeting (Washington, D.C.), Program and Abstracts, p. 67.

Casier, E. 1946. La faune ichthyologique de l'Ypresien de la Belgique.—Memoires du Musée Royal d'Histoire Naturelle de Belgique 104:1–267.

———. 1960. Note sur la collection des poissons Paléocenes et Eocenes de l'Enclave de Cavinda (Congo).—Annales du Musée Royal du Congo Belge (3) 1 (2):1–47.

———. 1966. Faune ichthyologique du London Clay.—British Museum (Natural History): London. 2 vols., 496 pp.

Clark, W. B., and G. C. Martin. 1901. The Eocene deposits of Maryland.—Maryland Geological Survey, Eocene, pp. 19–92.

Fallah, W. 1964. *Cylindracanthus* from the Eocene of the Carolinas.—Journal of Paleontology 38: 128–129.

Gibson, T. G., G. W. Andrews, L. M. Bybell, N. O. Frederiksen, T. Hansen, J. E. Hazel, D. M. McLean, R. J. Witmer, and D. S. van Nieuwenhaise. 1980. Geology of the Oak Grove Core, Part 2: Biostratigraphy of the Tertiary strata of the core.—Virginia Division of Mineral Resources, Publication 20:14–30.

Glaser, J. D. 1971. Geology and mineral resources of southern Maryland.—Maryland Geological Survey, Report of Investigations 15:1–84.

Hooker, J. J., A. N. Insole, R. T. J. Moody, C. A. Walker, and D. J. Ward. 1980. The distribution of cartilaginous fish, turtles, birds and mammals in the British Paleogene.—Tertiary Research 3(1):1–12.

Horman, S. R., and R. E. Weems. 1976. Eocene fish and reptiles from the Nanjemoy Formation in Maryland.—Geological Society of America, Abstracts of 25th Annual Northeastern/Southeastern Section 8(2):198.

Leriche, M. 1905. Les poissons Eocene de la Belgique.—Extrait Memoire Musée Royal d'Histoire Naturelle Belgique 3:49–228.

———. 1920. Notes sur la Paleontologie du Congo. III. Note préliminaire sur des poissons nouveaux du Paléocene et de l'Eocene de la region cotière du Congo.—Revue Zoologique Afrique 8:85.

———. 1943. Le synchronisme des formations Tertiares des deux côtes de l'Atlantique, d'apres leur faune ichthyologique.—Comptes Rendue de Séances de l'Academie des Sciences 210:589–592.

Loeblich, A. R., and H. Tappan. 1957. Correlation of the Gulf and Atlantic Coastal Plain Paleocene and lower Eocene formations by means of planktonic Foraminifera.—Journal of Paleontology 31:1109–1137.

McKenna, M. C. 1972. Was Europe connected directly to North America prior to the Middle Eocene?—*In* Dobzhansky, Hecht, and Steere eds. Evolutionary Biology, vol. 6, pp. 179–188. New York: Appleton-Century-Crofts.

Tavani, G. 1955. Osservazioni su alcuni Plectognathi (Gymnodonti).—Atti Societe Toscana Scienze Naturalle Memorie ser. A, 62:177–200.

Teifke, R. H. 1973. Stratigraphic units of the Lower Cretaceous through Miocene series, *in* Geological Studies, Coastal Plain of Virginia.—Virginia Division Mineral Resources Bulletin 83: 1–78.

Tyler, J. C. 1962. *Triodon bursarius,* a plectognath fish connecting the scleroderms and gymnodonts.—Copeia 4:793–801.

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